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Physiological and Productivity of Quail During The Egg-Laying Period with Supplementation of Senduduk (*Melastoma Malabathricum* L) Powder in Feed

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ABSTRACT

Quail is a type of poultry that is easy to raise and is the second largest egg producer after laying hens. The benefits of quail include a relatively high production cycle, minimal land requirements, and low feed consumption. Quail are more susceptible to stress compared to other poultry, particularly stress induced by elevated ambient temperatures. This stress can be overcome by administering antioxidants. *Melastoma malabathricum* L (commonly known as senduduk) leaf is a natural antioxidant that can alleviate stress. This study aimed to evaluate the effectiveness of different doses of senduduk leaf powder on the physiological and performance of laying quails. This study used a Completely Randomized Design with four treatments and four replications. The doses of senduduk leaf powder administered were P0 (0%), P1 (1.5%), P2 (3%), and P3 (4.5%). A total of 160 female quails, aged 40 weeks, were maintained for four weeks. The variables observed comprised hematological values, stress indicators, and quail performance during the laying period. The study's results on hematological values, stress indicators, and quail performance during the laying period showed an increase at a dose of 3% (P2). The optimal concentration was identified as the 3% dose of senduduk leaf powder in treatment P2.

Keywords: senduduk leaf, antioxidants, oxidative stress, quail

ABSTRAK

Puyuh merupakan salah satu jenis unggas yang mudah dipelihara dan penghasil telur terbesar kedua setelah ayam petelur. Keunggulan puyuh seperti siklus produksi relatif cepat, membutuhkan lahan sedikit dan kebutuhan pakan sedikit. Puyuh mudah mengalami stres dibandingkan unggas lain, terutama stres yang diakibatkan suhu lingkungan tinggi. Stres ini dapat diatasi dengan pemberian antioksidan. Salah satu antioksidan alami yang dapat menurunkan stres adalah daun senduduk. Penelitian ini bertujuan untuk mengkaji dan menganalisis efektivitas pemberian berbagai dosis tepung daun senduduk terhadap kinerja fisiologis dan performa puyuh periode bertelur. Penelitian ini menggunakan Rancangan Acak Lengkap dengan 4 perlakuan dan 4 ulangan, dosis tepung daun senduduk yang digunakan P0 (0%), P1 (1,5%), P2 (3%), dan P3 (4,5%). Puyuh betina yang digunakan berumur 40 minggu dengan jumlah 160 ekor dan dipelihara selama 4 minggu. Variabel yang diamati meliputi nilai hematologi, indikator stres, dan performa puyuh periode bertelur. Hasil penelitian mengenai nilai hematologi, indikator stres, dan performa puyuh periode bertelur mengalami peningkatan pada dosis 3% (P2). Konsentrasi terbaik adalah dosis pemberian 3% tepung daun senduduk yang terdapat pada perlakuan P2.

Kata kunci: daun senduduk, antioksidan, stres oksidatif, puyuh

INTRODUCTION

Quail (*Coturnix coturnix japonica*) is the second largest egg-producing poultry after laying hens. Quail has many advantages, including rapid growth, low feed consumption, small cage space requirements, and high productivity (Rinawidiastuti et al., 2019). Productivity is influenced by genetic and environmental factors, such as husbandry management, feed quality, and microclimate (Al-Sagan et al., 2020). Microclimate encompasses wind speed, light intensity, humidity, and ambient temperature (Utama et al., 2021).

According to data from the Meteorology, Climatology, and Geophysics Agency (BMKG, 2023), the temperature in Indonesia varies between 23-33°C, whereas the thermoneutral zone is limited to 18-21°C (Wasti et al., 2020). High temperatures can cause oxidative stress, a condition in which free radicals exceed the body's antioxidant capacity. An increase in free radicals can damage cells, weaken the immune system, and reduce livestock performance, evidenced by an increased heterophil-to-lymphocyte (H/L) ratio and elevated malondialdehyde (MDA) levels (Suarsana et al., 2013). Oxidative stress can be reduced with antioxidants. Antioxidants are classified into two categories: endogenous antioxidants, which are produced by the body, including glutathione peroxidase, catalase, and superoxide dismutase (SOD), and exogenous antioxidants, which are sourced from dietary or natural ingredients (Kumar et al., 2021). One source of exogenous antioxidants is senduduk leaves (Nurliyasman et al., 2022).

Senduduk Leaf (*Melastoma malabathricum* L.) is a wild plant that grows up to 1,650 meters above sea level (Utami et al., 2021). It is traditionally used as a remedy for diarrhea, ulcers, and burns (Sapitri et al., 2020). These leaves contain flavonoids, tannins, saponins, steroids, and terpenoids (Dongoran et al., 2023). Flavonoids act as antioxidants by stabilizing free radicals (Van De Wier et al., 2017), while tannins and saponins are antimicrobials by damaging bacterial cell membranes (Tugiyanti et al., 2019).

Numerous studies have demonstrated the advantages of senduduk leaves in poultry management. Nizajuha et al. (2018) found that a 4.5% senduduk leaf powder concentration effectively reduces cholesterol levels in laying hens. Dorisandi et al. (2018) found that administering 4.5% senduduk leaf powder influences the weight and length of the intestine, as well as the liver, heart, spleen, and gizzard of native chickens. Information on the use of senduduk leaves for quail is still limited. Therefore, this study aimed to assess the physiological performance of productivity of laying quails with the addition of senduduk leaf powder in feed.

MATERIALS AND METHOD

The study was conducted between December 2023 and January 2024. Senduduk leaf powder was produced in the Simpang Kanan District of Riau Province. Quantitative phytochemical analysis was conducted at the Research Institute for Spices and Medicines. Quail farming was conducted at Arkan Quail Farm in the Ciampea District of Bogor Regency. Blood samples from quails were analyzed at the Research and Diagnostic Laboratories of RSHP SKHB IPB. SOD and MDA testing was carried out at the Physiological Laboratory of of RSHP SKHB IPB. The work procedures in this study have been approved by the Ethics Committee of the Animal Health and Breeding IPB University under number 160/KEH/SKE/I/2023.

Experimental Animal

This study used 160 female quails aged 40 weeks, which were divided into four treatment groups, each consisting of 10 quails. The initial group served as the control group (P0) and received no treatment, whereas group P1 was administered 1.5% senduduk leaf powder, group P2 received 3%, and group P3 was given 4.5%. The 4.5% dose was chosen based on previous research that showed optimal results. This study also used doses of 1.5% and 3%. The variation in dosage aimed to evaluate the efficacy of a lower dose in delivering benefits and to identify the optimal dosage for quail health.

Research Procedure

Preparation and Phytochemical Analysis of Senduduk Leaf Powder

The leaves used were fresh and undamaged, picked from the center and tips of the plant, and harvested at intervals of two to three months. Drying was conducted at room temperature for 3-4 days. After drying, the leaves were ground using a grinder. The leaves were then analyzed phytochemically following the method by Noer et al. (2018) and then tested using UV-Vis spectrophotometry and TLC Scanner.

Quail Rearing

Quail rearing includes cage preparation, temperature recording, feed and drinking water provision, and performance observation. Cage preparation includes cleaning, disinfection, and the installation of treatment labels. Temperatures were recorded daily in the morning (6:00-7:00 a.m.), afternoon (12:00-1:00 p.m.), and evening (4:00-5:00

p.m.). Feed was provided in the morning and evening, while drinking water was available *ad libitum*. Observations during the rearing period focused on feed consumption, egg production, feed conversion, and mortality rates. After the rearing period, blood and liver samples were collected from the quail to assess physiological responses.

Quail Blood Sampling

Quail blood samples were taken from the brachial vein using a 1 cc syringe and placed in an EDTA tube. The blood was combined with EDTA by rotating the tube to ensure even mixing. The blood tube was subsequently placed in a cooler box to ensure stability. Blood tests include erythrocyte count, hemoglobin level, hematocrit, erythrocyte index, leukocyte count, and leukocyte differentiation.

Physiological Performance

The assessment of physiological performance encompassed hematological analysis and stress indicators. The hematological analysis included looking at the number and types of erythrocytes, hemoglobin, hematocrit, and erythrocyte indices (MCV, MCH, and MCHC), as well as the number and types of leukocytes (heterophils, lymphocytes, monocytes, eosinophils, and basophils). Erythrocytes and leukocytes were quantified utilizing a Neubauer hemocytometer. The analysis of hemoglobin and hematocrit was conducted utilizing a Mindray BC-2800 Vet Auto Hematology Analyzer (Santoso et al., 2022). Leukocyte differentiation involved quantifying the number of heterophils, lymphocytes, monocytes, eosinophils, and basophils. The stress indicators analyzed comprised SOD, MDA, and the H/L ratio. SOD testing was conducted following the method established by Maskar et al. (2015). MDA was measured using the thiobarbituric acid reactive substance (TBARS) method, as described by Ulhusna et al. (2019). The H/L ratio was derived from the results of leukocyte differentiation analysis.

Data Analysis

Data was analyzed using ANOVA and Duncan's test to identify significant differences between treatments. The results are presented in average form in tables.

RESULTS

Rearing Temperature

The quail rearing temperature during the study is presented in Table 1.

Table 1. The rearing temperature of quails during the egg-laying period

Parameters	Morning (06.00-07.00)	Noon (12.00-13.00)	Afternoon (16.00-17.00)
Temperature (°C)	24-26	32-38	28-30
Humidty (%)	80-92	54-76	78-87

Phytochemical Content of Senduduk Leaf Powder

Table 2 presents the phytochemical content of senduduk leaf powder. The phytochemical results indicate that three of the five tested compounds—flavonoids, tannins, and saponins—were quantitatively detected. The identified steroids and triterpenoids demonstrated positive results; however, quantitative calculations were not performed. The total concentration of these three primary compounds was 9%, indicating that senduduk leaves exhibit antioxidant properties against free radicals.

Tabel 2. Phytochemical content of senduduk leaf powder

Phytochemical Test	Result (%)
Flavonoids	1.05
Tannins	7.66
Saponins	1.23
Steroids	+
Triterpenoids	+

Physiological Performance

Table 3 presents the results of the observations on erythrocytes, Table 4 presents the observations on leukocytes and their differentiation, and Table 5 presents the observations on stress indicators.

Quail Performance

Table 6 presents observations of the performance of quails fed with senduduk leaf feed. Observational results during rearing indicate that the highest mortality rate occurs in P0 (Figure 1).

DISCUSSION

Rearing Temperature

The rearing temperature in this study varied between 24°C and 38°C throughout the day, with humidity levels frequently surpassing 80%. This range is deemed elevated compared to the optimal

Table 3. The quantity of erythrocytes in quail during the egg-laying period when supplemented with senduduk leaf powder

Paramaters	P0	P1	P2	P3
Erythrocytes (cells/µL)	2.64±0.30^{b}	2.76±0.13^{b}	2.89±0.21^{a}	2.78±0.12^{b}
Hemoglobin (g dL)	14.35±2.69^{b}	14.63±2.22^{b}	16.63±0.20^{a}	16.28±1.27^{a}
Hematocrit (%)	36.98±3.59^{b}	39.13±1.09^{b}	41.25±2.40^{a}	41.03±1.64^{a}
Erythrocyte Index				
MCV (fl)	141.40±10.49^{a}	140.38±3.74^{a}	130.70±4.34^{b}	136.35±6.55^{a}
MCHC (g dL)	39.20±0.64^{a}	41.40±1.43^{b}	44.10±1.97^{a}	43.95±2.70^{b}
MCH (pg)	51.20±0.93^{a}	56.45±4.19^{b}	62.33±8.34^{a}	61.90±3.91^{b}

The same superscript on the line indicates no significant difference (P>0.05). P0: without Senduduk leaf powder; P1: 1.5% Senduduk leaf powder; P2: 3% Senduduk leaf powder; P3: 4.5% Senduduk leaf powder; N/D: non-detect.

Table 4.The quantity and differentiation of leukocytes in quail during the egg-laying period when supplemented with senduduk leaf powder

Parameters	P0	P1	P2	P3
Leukocytes (sel/µL)	21.63±3.46^{a}	20.37±1.50^{ab}	18.50±0.47^{bc}	17.30±0.68^{c}
Leukocyte differentiation (%)				
Heterophils	29.92±2.26^{a}	29.25±0.50^{b}	26.25±2.50^{c}	23.50±1.91^{d}
Lymphocytes	59.83±2.62^{b}	60.25±3.66^{b}	63.25±1.98^{a}	65.00±0.81^{a}
Monocytes	6.00±0.00	6.00±0.00	6.00±0.00	6.00±0.00
Eosinophils	4.25±0.95^{b}	4.5±1.29^{b}	4.5±1.29^{b}	5.5±3.69^{a}
Basophils	N/D	N/D	N/D	N/D

The same superscript on the line indicates no significant difference (P>0.05). P0: without Senduduk leaf powder; P1: 1.5% Senduduk leaf powder; P2: 3% Senduduk leaf powder; P3: 4.5% Senduduk leaf powder; N/D: non-detect.

Table 5. Stress indicators in quails during the egg-laying period observed over a 30-day duration

Parameters	P0	P1	P2	P3
Oxygen Saturation (%)	90.56±0.23^{b}	91.79±0.99^{b}	95.22±0.51^{a}	94.43±2.63^{a}
H/L (%)	0.50±0.07^{a}	0.48±0.01^{a}	0.41±0.04^{b}	0.36±0.03^{c}
Liver SOD (unit/mL)	58.11±7.54^{b}	61.95±3.60^{ab}	62.15±3.76^{a}	59.22±4.63^{b}
Liver MDA (unit/mL)	0.05±0.03^{a}	0.04±0.0^{a}	0.02±0.00^{b}	0.04±0.02^{a}

The same superscript on the line indicates no significant difference (P>0.05). P0: without Senduduk leaf powder; P1: 1.5% Senduduk leaf powder; P2: 3% Senduduk leaf powder; P3: 4.5% Senduduk leaf powder.

Table 6. Quail performance during the egg-laying period observed over a 30-day duration

Parameters	P0	P1	P2	P3
Feed Intake (g/bird/day)	22.48±0.51^{b}	22.64±0.27^{b}	23.40±0.08^{a}	23.07±0.20^{ab}
Egg Production (%)	61.21±4.39^{c}	64.88±2.13^{bc}	73.08±1.85^{a}	69.95±2.44^{ab}
Egg Weight (g/egg)	10.38±0.28^{d}	10.76±0.19^{c}	11.62±0.07^{a}	11.17±0.03^{b}
Egg Mass (kg)	7.00±0.19^{b}	7.82±0.14^{b}	9.80±0.07^{a}	6.91±0.08^{a}
Feed Conversion Ratio	3.54±0.19^{a}	3.24±0.32^{a}	2.76±0.05^{c}	2.95±0.11^{b}
Mortality (bird)	9	4	2	2

The same superscript on the line indicates no significant difference (P>0.05). P0: without Senduduk leaf powder; P1: 1.5% Senduduk leaf powder; P2: 3% Senduduk leaf powder; P3: 4.5% Senduduk leaf powder.

Figure 1 Quail that died on P0

temperature suggested by Wasti et al. (2021), which is approximately 20-21°C, alongside an ideal humidity level of 50-70%, as indicated by Santos et al. (2019). Increased temperatures result in higher fluid loss in quails. High humidity levels hinder the quail's ability to dissipate heat from its body. The elevated temperature can induce oxidative stress, a state in which the quantity of free radicals in the body surpasses its natural antioxidant capacity. Oxidative stress adversely affects the metabolism and health of quails. Excess free radicals cause cellular damage by oxidizing lipids, proteins, and DNA, potentially leading to decreased productivity. Additional antioxidants are required to balance this condition. The senduduk leaf is a source of natural antioxidants, containing a high concentration of bioactive compounds that contribute to mitigating oxidative stress.

Phytochemical Content of Senduduk Leaf Powder

Flavonoids function as antioxidants by neutralizing free radicals by donating hydrogen atoms (Van De Wier et al., 2017). Tannins and saponins exhibit antibacterial and antimicrobial properties by inhibiting bacterial enzymes and depleting essential nutrients. Saponins specifically disrupt the stability of bacterial cell membranes, leading to cell lysis (Tugiyanti et al., 2019). Steroids damage the lipid membrane of bacteria, causing damage and lysis of bacterial cells (Sari et al., 2017). Triterpenoids inhibit bacterial growth by damaging their cell walls (Hamzah et al., 2021). Senduduk leaf powder possesses antioxidant and antimicrobial properties that promote health maintenance and growth.

Erythrocyte Count

This study observed a lower erythrocyte count than the normal range of approximately 2.64-2.89 cells/µL. In contrast, Mahmoud et al. (2013) reported erythrocyte counts ranging from 2.97-3.43 cells/µL. The reduced erythrocyte count suggests that the quails underwent heat stress. Following the administration of senduduk leaf powder, a notable increase in erythrocyte levels was recorded, particularly in group P2, which exhibited a significant difference compared to the other groups ($P<0.05$). The use of senduduk leaf powder demonstrates a reduction in the adverse effects of heat stress on erythrocyte count.

Quail in P2 and P3 exhibited significantly higher hemoglobin levels ($p<0.05$) compared to those in P0 and P1. The increase might be attributed to the iron (Fe) content in senduduk leaves, essential for hemoglobin synthesis and oxygen transport (Fitriana et al., 2022). Flavonoids present in senduduk leaves enhance iron absorption. Saponins function as immunostimulants that enhance the production of red blood cells (Maknun et al., 2015).

This study's results indicate increased hematocrit levels in quails fed with senduduk leaf powder (groups P2 and P3). Statistically, the difference between groups was insignificant ($P>0.05$), suggesting that variables beyond the administered treatment may influence hematocrit levels.

The mean corpuscular volume (MCV) in quails fed with Senduduk leaf powder was within the normal range of 130.70-141.40 fl, as reported by Mahmoud et al. (2013), which indicated a range of 136.71-151.82 fl. The MCV value varied among groups but was not statistically significant ($P>0.05$). The Mean Corpuscular

Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) exhibited significant increases. This suggests that senduduk leaf powder enhances hemoglobin levels in erythrocytes, thereby improving the capacity for oxygen transport in the blood.

Leukocyte Count

Leukocytes, commonly known as white blood cells, are integral components of the immune system. The findings indicated that the leukocyte count in quails was maintained within the normal range of 17.20-22.91 cells/µL (Mahmoud et al., 2013). P2 and P3 exhibit a statistically significant difference ($p<0.05$). The reduction in leukocyte count in P2 and P3 remains within normal limits. The administration of senduduk leaf powder does not adversely affect the immune system of quails.

Leukocyte differentiation consists of heterophils, lymphocytes, monocytes, eosinophils, and basophils, each playing a specific role in the immune system. The results indicated that the percentage of heterophils in P0 was significantly higher than in P1, P2, and P3 ($p<0.05$). The percentage of lymphocytes increased with a decrease in heterophils, with P3 having the highest value. The lower heterophil-lymphocyte ratio in P2 and P3 indicates lower stress compared to P0 and P1. Monocytes remain stable in all groups, while eosinophils tend to increase in P3. The absence of basophils in all groups suggests a normal immune response. The findings suggest that the administration of senduduk leaf powder might reduce physiological stress in quails while preserving immune function.

Stress Indicator

The study revealed that the introduction of senduduk leaf powder (P2) led to the highest oxygen saturation at 95.22%, a result that was significantly different ($P<0.05$) from the other groups. Groups P1 and P3 remained within the normal range. Jumadin et al. (2022) reported that oxygen saturation in quails ranged from 89.50% to 95.00%, indicating that the quails are in good health. The increase in oxygen saturation in P2 can be attributed to the bioactive compounds present in senduduk leaves, which enhance the efficiency of oxygen binding in the blood.

The findings of this study indicate that the H/L ratio in P2 and P3 was significantly lower compared to P0 and P1. This suggests reduced stress levels in P2 and P3. The H/L ratio observed in this study varied from 0.36% to 0.50%, remaining within the normal range. Fadhila et al. (2023) found that the H/L ratio ranged from 0.38% to 0.45%, suggesting that natural ingredients like flavonoids, tannins, and saponins may contribute to stress reduction in quails. The notable reduction in the H/L ratio ($P<0.05$) in P2 and P3 indicates the beneficial impact of senduduk leaf powder on reducing stress and enhancing the health of quails.

The administration of senduduk leaf powder at a dose of 3% (P2) resulted in the highest liver SOD level, which was 62.15±3.76a units/mL. Statistically, this value was not significantly different from P1 but was significantly different from P0 and P3 ($p<0.05$). The SOD level in P2 remained within the normal range, as indicated by Jumadin et al. (2022), who reported a range of 59.94-62.25 units/mL. The increase in SOD levels can be attributed to the flavonoid content in senduduk leaves, which acts as an antioxidant and enhances SOD activity, thereby aiding in the neutralization of free radicals and the reduction of oxidative stress (Van de Wier et al., 2017).

The group P0 exhibited the highest liver MDA level, measuring 0.05 units/ml. Elevated oxidative stress resulting from heat stress enhances the production of free radicals and initiates lipid peroxidation. Groups P1, P2, and P3 exhibited a significant reduction in MDA levels ($P<0.05$), demonstrating the efficacy of senduduk leaf powder in mitigating oxidative stress. The reduction in MDA levels in the treatment group remained within the normal range, suggesting that the incorporation of senduduk leaf powder did not adversely affect the health of the quail.

Quail Performance

The quail feed consumption in this study ranged from 22.48 to 23.40 g/bird/day, which was statistically significant ($p<0.05$). The reported value is lower than the findings of Jumadin et al. (2022), who indicated a consumption range of 25.97-29.61 g/bird/day with an addition of cassava leaf paste. The main factors affecting feed consumption are age, ambient temperature, and metabolic energy content of feed (Mone et al., 2016).

The addition of *Moringa oleifera* leaf powder has a notable impact on egg production, with treatment P2 exhibiting the highest production percentage in comparison to P0, P1, and P3. The increase in egg production in P2 may be attributed to the flavonoid and mineral content, which improves nutrient absorption. The decrease in production in P3 is likely due to excess tannin content, which can bind to protein (Marzoni et al., 2020).

Application of senduduk leaf powder resulted in a significant increase in the weight of quail eggs ($p<0.05$), attributed to the flavonoid content enhancing the nutrient composition of the eggs (Abdel-Wareth & Lohakare, 2021). Egg mass is influenced by feed

consumption, egg weight, and the quantity of egg production (Maknun et al., 2015).

The optimal feed conversion ratio was achieved at P2, recorded at 2.82, which was statistically significant ($p<0.05$). A reduced conversion value signifies enhanced nutrient absorption efficiency (Mone et al., 2016). Saponins in senduduk leaf powder function as antibacterials, reducing the population of pathogenic bacteria in the intestine and consequently enhancing feed efficiency.

The highest quail mortality occurs in P0, characterized by symptoms including respiratory infections, eye swelling, and nasal secretions. This characteristic signifies a coryza infection resulting from *Avibacterium paragallinarum* (Vargas, 2021). Lower mortality in P1, P2, and P3 might be due to the saponin and tannin content in senduduk leaf powder, which functions as an antibacterial, increasing endurance to reduce the risk of death (Nugrahaning et al., 2020).

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